

## **Title: Which Line Fits Best?**

### **Link to Outcomes:**

- **Problem Solving** Students will demonstrate their ability to solve problems in mathematics, including problems with open-ended answers, problems which are solved in a cooperative atmosphere, and problems which are solved with the use of technology.
- **Communication** Students will demonstrate their ability to communicate mathematically. They will write and discuss mathematics with the language and the signs, symbols, and terms of the discipline.
- **Reasoning** Students will utilize gathered data to make conjectures.
- **Connections** Students will demonstrate their ability to connect algebraic topics to measurement.
- **Estimation** Students will demonstrate their ability to apply estimation strategies.
- **Geometry** Students will demonstrate their ability to apply geometric properties and relationships and to represent relationships on a two dimensional graph.
- **Measurement** Students will demonstrate their ability to apply concepts of measurement to circles.
- **Statistics** Students will demonstrate their ability to collect and display data .
- **Algebra** Students will demonstrate their ability to perform algebraic concepts involving graphs and equations.
- **Patterns/ Relationships** Students will demonstrate their ability to recognize numeric and geometric relationships and will generalize a relation from data.
- **Technology** Students will demonstrate their ability to use a graphing calculator to determine lines of best fit.

### **Brief Overview:**

Students will work in groups to collect data on circumference and diameter of various objects. They will be asked to construct and describe a scatter plot, estimate the line of best fit, and determine the relationship between the slope of the line and the formula for the circumference of the circle.

### **Grade/Level:**

Grade 8 or 9 Algebra Classes

### **Duration/Length:**

Three class periods will be needed for this lesson.

**Prerequisite Knowledge:**

Students should have the following skills:

- collecting and organizing data
- graphing in the coordinate plane
- constructing a scatter plot
- finding the equation of a line given two points
- using a graphing calculator
- calculating circumference and area of circles.
- working in cooperative learning groups
- measuring lengths

**Objectives:**

Students will:

- work cooperatively in groups.
- measure circumference and diameter to the nearest mm using string and rulers.
- collect and organize data.
- construct a scatter plot.
- write a description of the scatter plot.
- recognize and describe the types of correlations possible on scatter plots.
- estimate a line of best fit.
- determine the equation of a line of best fit.
- use a graphing calculator to determine a line of best fit ( line of regression).
- determine the relationship between the slope of the line of best fit and the formula for the circumference of a circle.

**Materials/Resources/Printed Materials:**

- metric rulers
- string
- overhead markers in several colors - 1 color for each group
- overhead black line grids - 2 per group
- graphing calculators
- overhead plastic black lines - 1 per student
- worksheet #1 - 1 per student
- worksheet #2 - 1 per student
- calculator procedure worksheet - 1 per student
- round or cylindrical objects (no larger than 200 mm in diameter) - 6 per group

**Development/Procedures:****Measuring and Plotting:**

- Arrange class into groups of five.
- Explain the data collection procedures.
- Distribute the worksheets and supplies.
- Complete worksheet 1.
- Have the group recorder duplicate the scatter plot on an overhead grid and turn it in.

**Analyzing:**

- Combine the scatter plots on the overhead.
- Lead class discovery of the correlation and trend pattern.
- Have students complete the mathematical description of the combined plots.
- Distribute overhead plastic black lines.
- Have each group estimate the position of the trend line of their plot by completing worksheet 2.
- Have the group recorder draw the line on the second overhead grid and turn it in.
- Test each trend line on the combined scatter plot and have the class decide which is the best fit line.
- Generalize the procedure to find the line of best fit by estimated position and then assign practice.
- Stress that estimated best fit lines will have slightly different equations.

**Calculating:**

- Distribute graphing calculator procedure and calculators.
- Lead class through entire procedure on a selected subset of data to find the line of best fit.
- Discuss the slope of the line (approximately  $\pi$ )
- Have each student use the graphing calculator to find the line of best fit for the group data.
- Write a paragraph comparing the equation from the estimated position with the calculator equation.
- Collect worksheets, practice and paragraph as a packet.

**Evaluation:**

Students will be evaluated on gathering and recording data, working cooperatively and completing the packet of worksheets.

**Extension/Follow Up:**

This unit could be extended by using the formula for the area of a circle or square to repeat this experiment and find the quadratic relationship between the radius and area of the circle, or side and area of a square.

This experiment could be repeated using the perimeter of a square to show the same relationship.

This unit could also be extended by using the circumference formula to develop the concept of direct variation.

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## Which Line Fits Best?

## WORKSHEET 1 - SCATTER PLOT

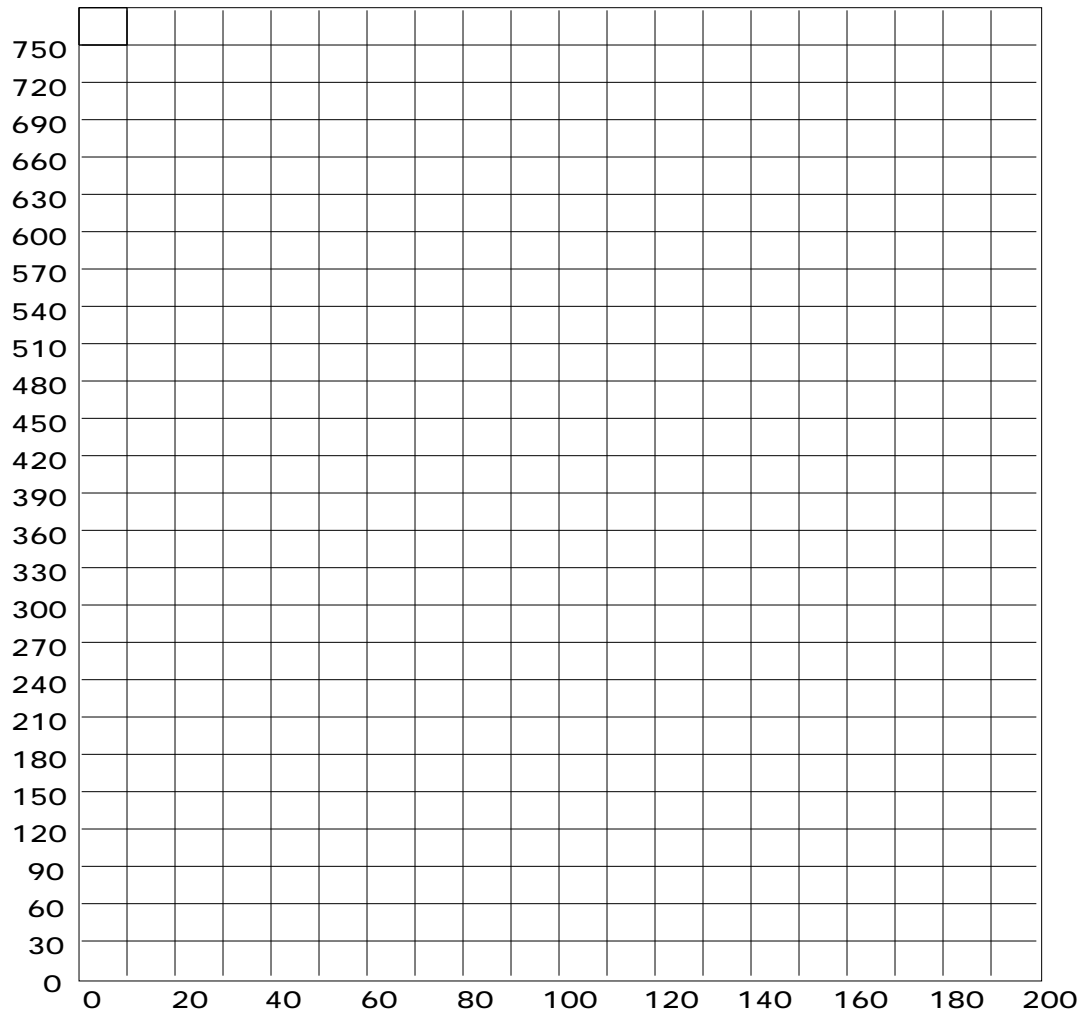
**Name**\_\_\_\_\_

**Date** \_\_\_\_\_

**Each group will:**

1. Select a recorder, two students to measure with rulers, and two to measure with string.
2. Measure the diameter and circumference of each of the objects to the nearest mm.
3. Complete worksheet individually.
4. Record the data in the table below.
5. Plot the points on the coordinate grid using the x-axis for the diameter and the y-axis for the circumference.
6. Transfer the scatter plot to the overhead grid and turn it in.

[illegible]



## Which Line Fits Best?

### WORKSHEET 1 - continued

Name \_\_\_\_\_

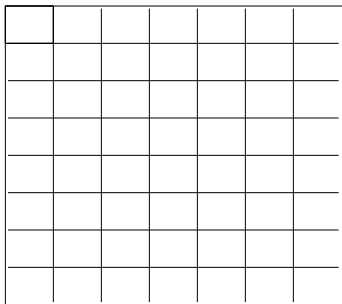
Date \_\_\_\_\_

Each student should answer the following questions:

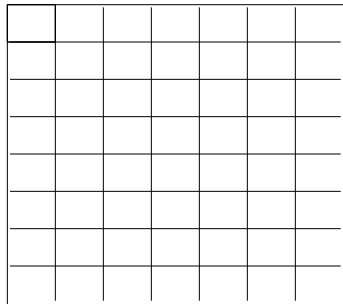
1. Write two or three sentences describing what patterns you see in the graph.

2. Mathematically describe the class scatter plot.

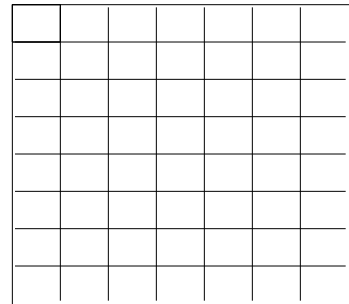
3. Sketch a scatter plot to illustrate each correlation.



**Negative correlation**



**No correlation**



**Positive correlation**

## **Which Line Fits Best?**

### **WORKSHEET 2 - ESTIMATED TREND LINE**

**Name** \_\_\_\_\_

**Date** \_\_\_\_\_

**Each group will:**

- 1. Position the black line over each individual student's scatter plot to indicate where a trend exists.**
- 2. Choose two points on the line and draw the line.**
- 3. Find the equation of the line.**
  
- 4. Compare the lines and equations among group members. Decide which line best represents the trend.**
  
  
  
  
  
  
  
  
  
  
- 5. Transfer the line to the second overhead grid and turn it in.**

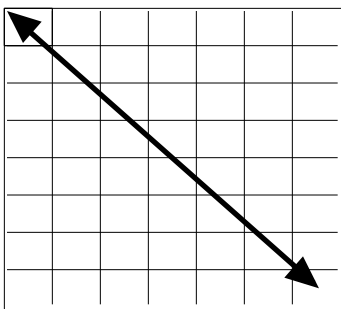
**STUDENT NOTES**

## Answers to Worksheet 1

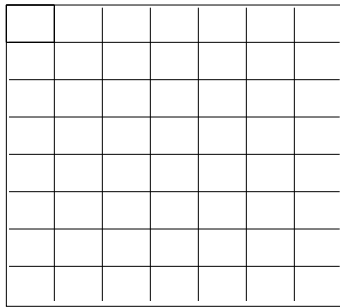
The answers to steps 1-6 will vary from group to group.

Questions.

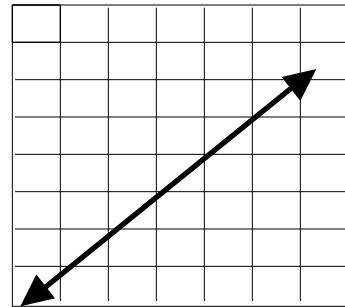
1. The scatter plot follows a linear pattern that appears to intersect at (0,0).
2. Students should describe a linear pattern with a positive correlation.
3. Students should graph data points on or around the lines graphed below.



**Negative correlation**



**No correlation**



**Positive correlation**

## Answers to Worksheet 2

Student responses will vary according to data collected. The ideal equation of the line should be  $y=3.14x$ .



## INSTRUCTIONS FOR THE GRAPHING CALCULATOR:

••These instructions are for the TI-80 calculator. If you have a different calculator, please refer to your manual for instructions.••

### Before you begin:

Press **Clear** to clear anything that may be on your screen. You should now have a blank screen with the cursor blinking.

Press **STAT** and choose **4 Clrlist** **2<sup>nd</sup> L1** , **2<sup>nd</sup> L2** Enter. This will clear any data previously entered in lists 1 and 2 in your calculator.

Press **2<sup>nd</sup> STAT PLOT** to retrieve the stat plot menu. Choose **4 Plotsoff** and press **Enter** to clear any old plots that may be already in memory.

Press **Y=** then **Clear** to clear any graphs which may already be present in your Y= menu.

### To input data:

Press **STAT**, then **Enter** to input data. You will see two lists L1 and L2 displayed. You will begin typing the L1 list which will be the values for the diameter of each circular object. Press the appropriate value for the diameter and press **Enter**. The screen will automatically be highlighted to the next value. When you finish entering all diameters, press the right arrow key ( **→** ) to input the L2 values or the circumference values in the same manner. Be sure you have the L2 values that correspond to the appropriate L1 values.

### To graph the scatter plot:

Press **2<sup>nd</sup> STAT PLOT** to retrieve the stat plot menu. 1 PLOT will be highlighted. Press **Enter**. OFF will be highlighted. Use left arrow key ( **←** ) to highlight ON and press **Enter**. This will turn on the plot. Use the down arrow key ( **↓** ) to highlight the scatter plot. It will be the first graph after Type. Press **Enter**. Use the down arrow key ( **↓** ) to L1 and press **Enter**. Use the down arrow key ( **↓** ) to L2 and press Enter.

Press **Window**. This is where you set how big your viewing area will be. The window should be set so that the XMin and XMax correspond to the values in your L1 list. The same should be done for the YMin and YMax values.

Press **Graph**. The display should show your scatter plot.

### To find the equation of the line of best fit:

Press **STAT** and use the right arrow key to CALC. This will give you a new menu.

Choose 3 LinReg(aX+b). The display LINREG(aX+b). Choose **2<sup>nd</sup> L1** , **2<sup>nd</sup> L2** and hit **Enter**. The display will now show values for a, b, and r.

### To graph this line:

Choose **Y=** then **Y- VARS**. Choose 2 STATISTICS. Use right arrow keys ( **→** ) to EQ and choose 5 REGEQ. The a and b values will appear in the Y1 equation. Press **Graph** to display the line of best fit.

# Transparency for Worksheets

